

Lead-acid battery overview and advanced research pilots

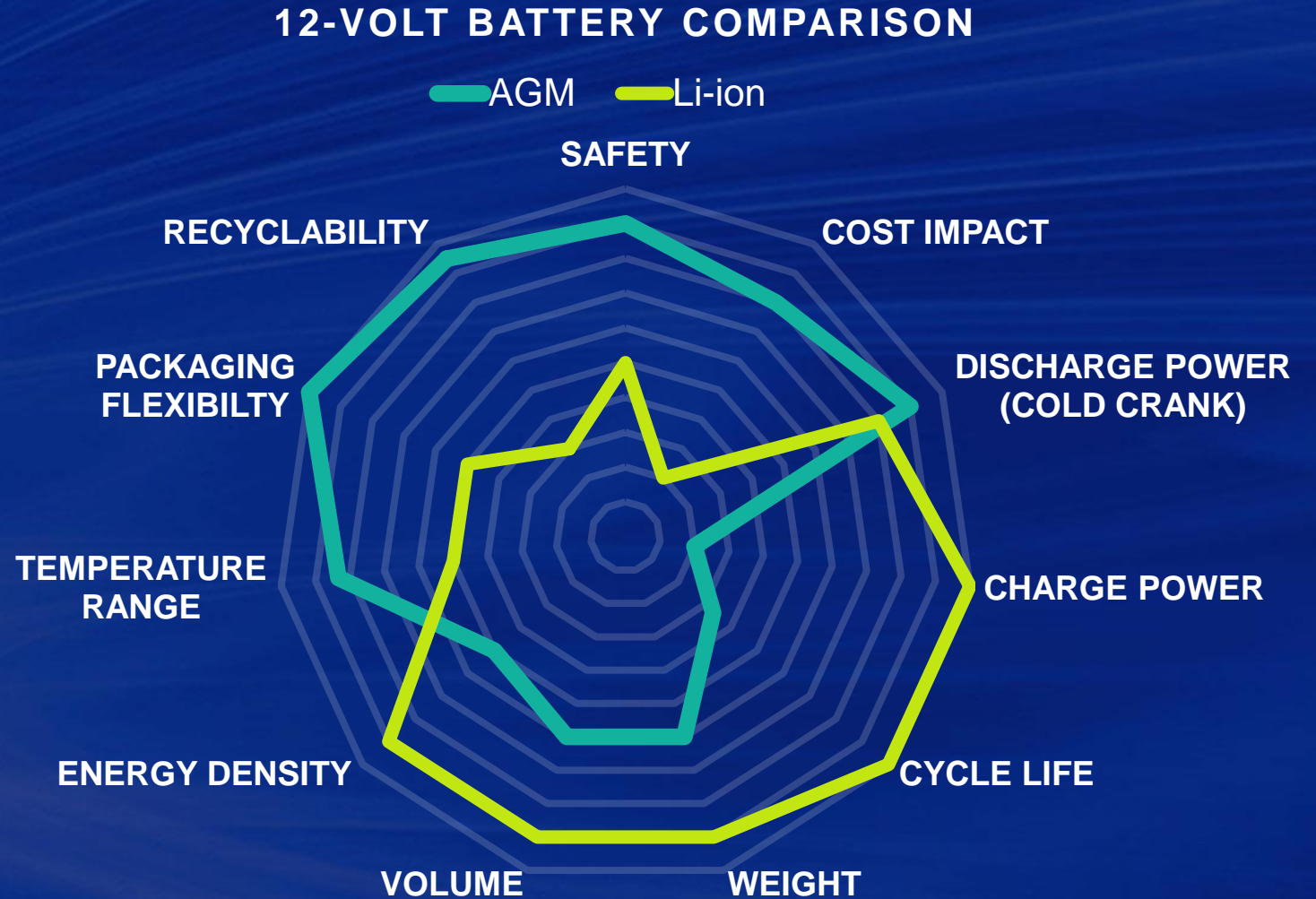
Public Workshop on Lead-Acid Batteries and Alternatives
Monday, November 6, 2017
California Environmental Protection Agency
Sacramento, California

Adam Muellerweiss
Executive Director – Sustainability, Industry and Government Affairs
Johnson Controls Power Solutions
Battery Council International
Motor Equipment Manufacturers Association



LEAD ACID BATTERIES CONTINUE TO HAVE SIGNIFICANT ADVANTAGES IN HIGH VOLUME VEHICLE APPLICATIONS

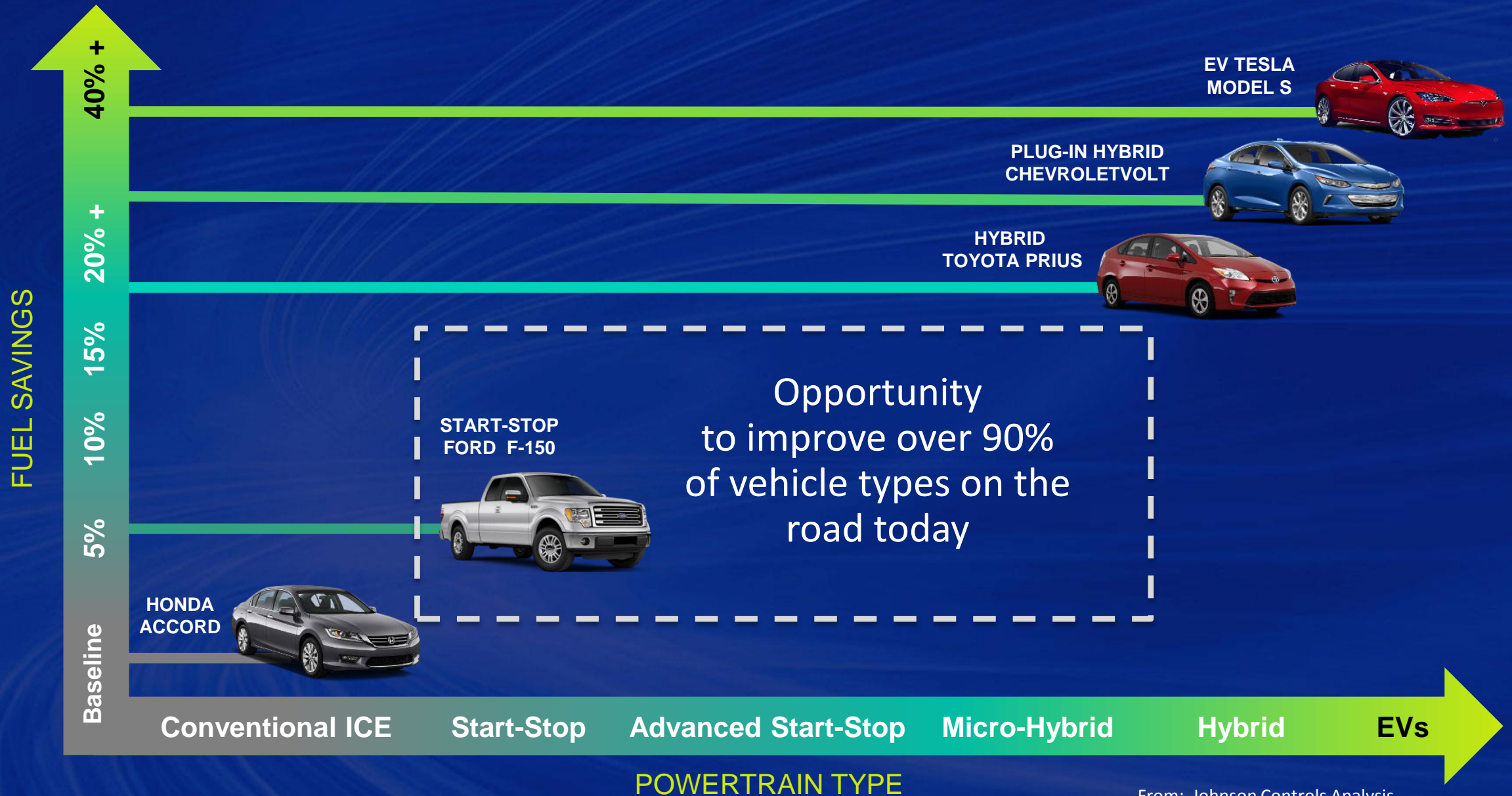
- No single battery technology is the perfect solution
- Advanced Absorbent Glass Mat (AGM) Lead-Acid continues to pace the market
- Lithium-ion is complimentary for specific electrification needs



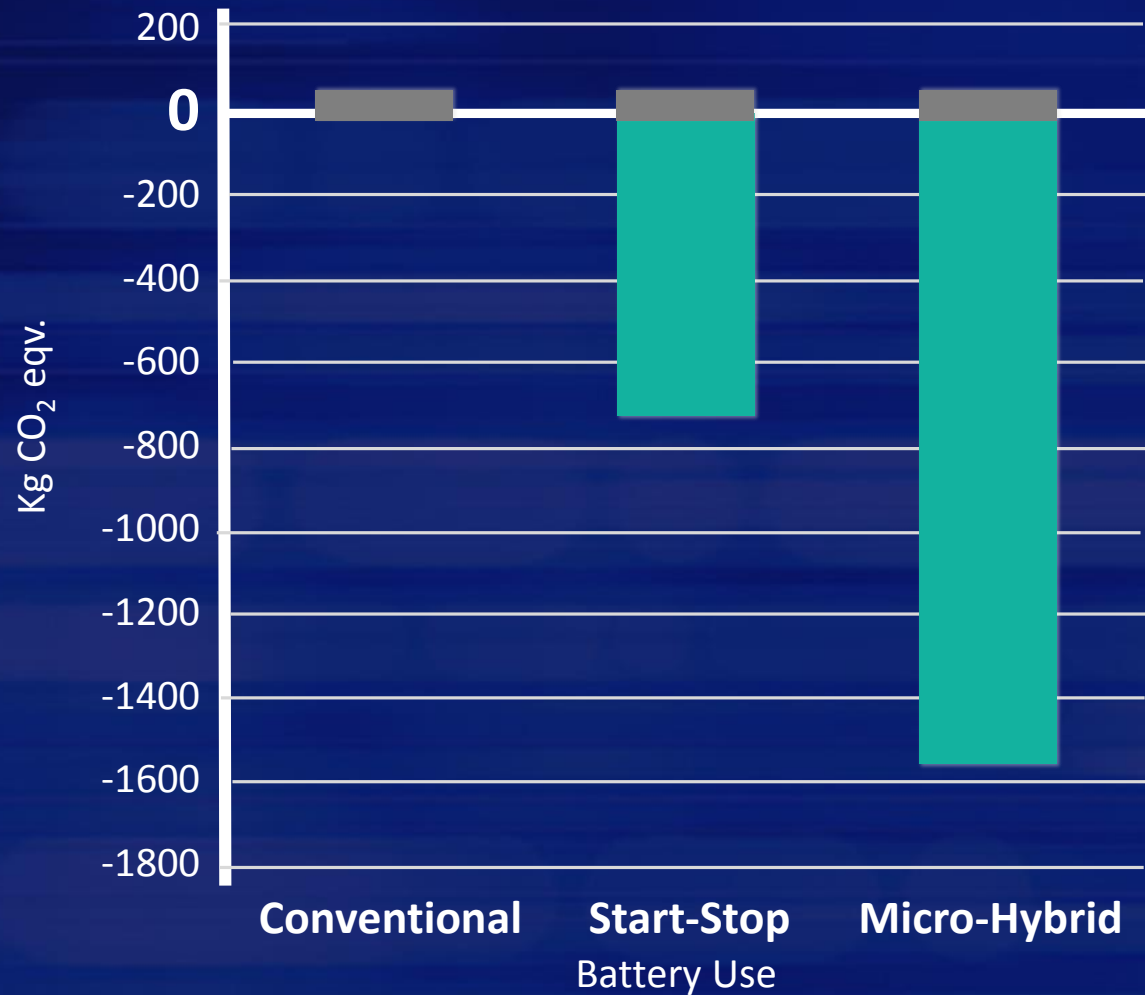
From: Johnson Controls Analysis

Note: Center lower performing, outer rings better performing

VEHICLE ELECTRIFICATION CONTINUUM



NET GHG IMPACTS AND SAVINGS FROM LEAD-ACID BATTERIES



From: Life Cycle Assessment of Lead-based Batteries for Vehicles, PE International for EUROBAT – The European Association of Battery Manufacturers

Manufacturing Impact
Savings from battery & engine application

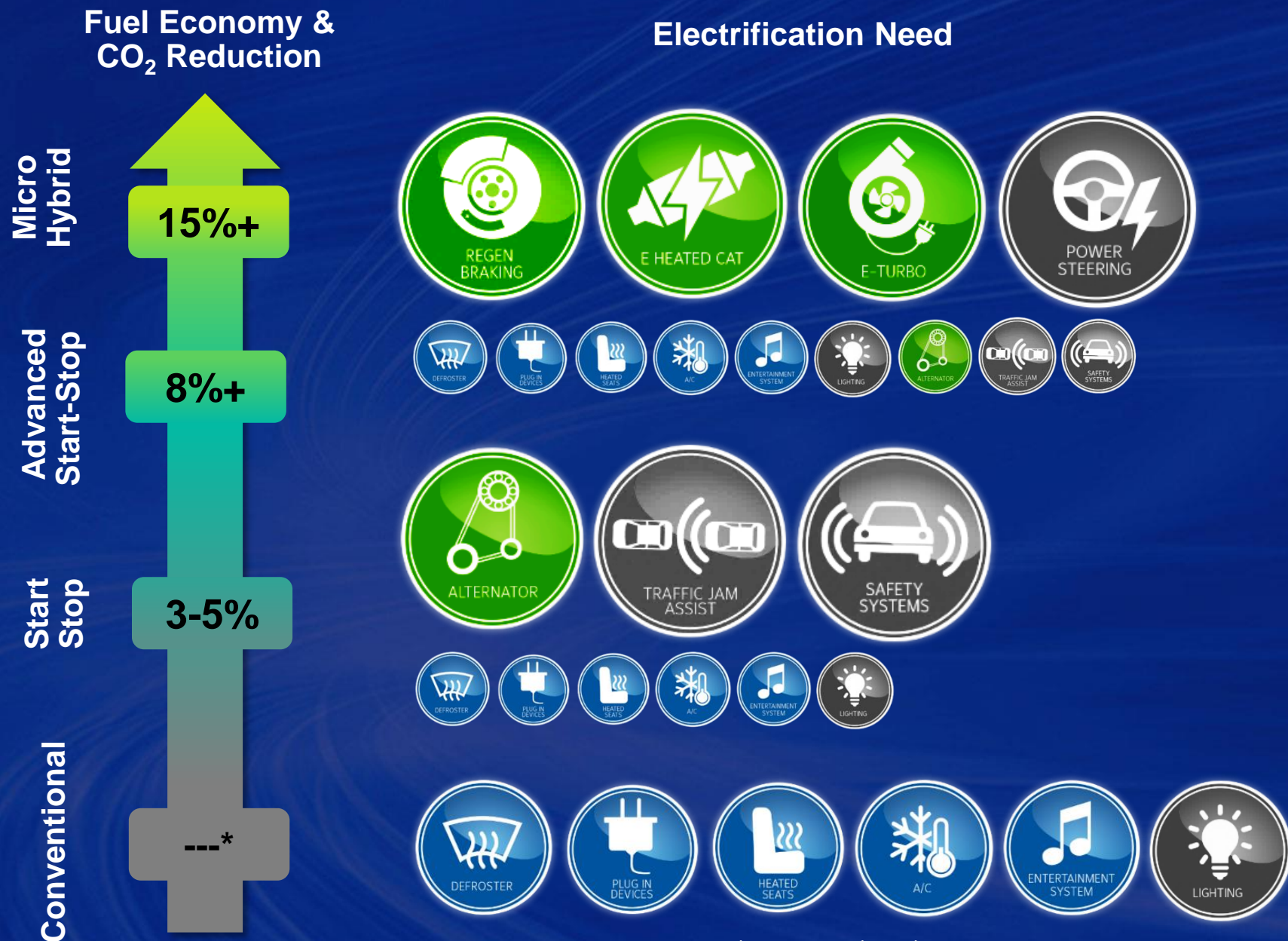


Start-Stop AGM Battery Technology Today's Energy & GHG Benefits

- In over 35 million vehicles globally
- Reducing fuel costs up to 5%
- Saving each year 60 million gallons of fuel and 5.9 million metric tons GHG
- Recycled versus virgin materials results in 90% less supply chain GHG emissions

From: Johnson Controls Estimates

LOW VOLTAGE AUTOMOTIVE ENERGY STORAGE TECHNOLOGY



Johnson Controls Recommended Technology

Li Ion



**Advanced
Absorbent
Glass Mat
(AGM)
Lead-Acid
Technology**

A CRITICAL BALANCE OF FACTORS REGARDLESS OF BATTERY TECHNOLOGY

BUSINESS REQUIREMENTS



Favorable
cost-benefit



Ability to make
at world-scale



Operational safety
& Product
stewardship



Responsible &
Resilient
supply chain

PRODUCT & TECHNOLOGY REQUIREMENTS



Proven ability
to meet specs



Weight & space



Product
safety



Deep discharge
capability



Charge
acceptance
& Recharge
speed



Effective
operating
temperatures



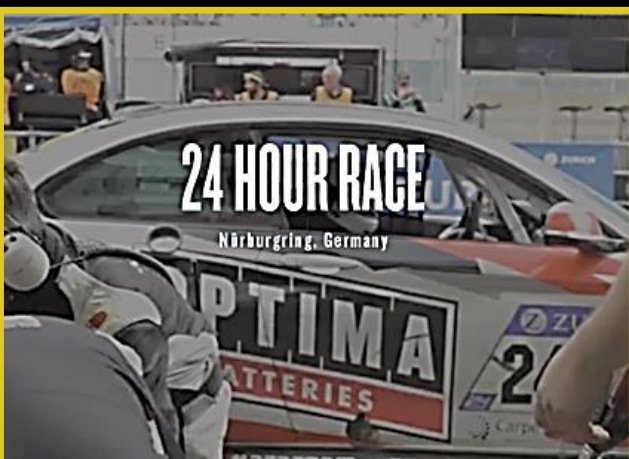
Cycle-life &
durability



Recyclability,
recovery &
reuse



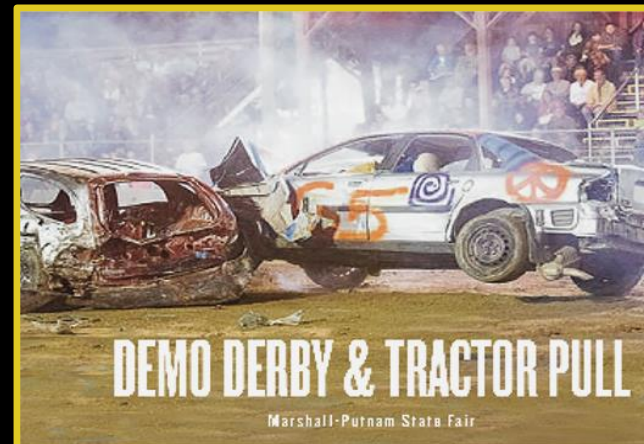
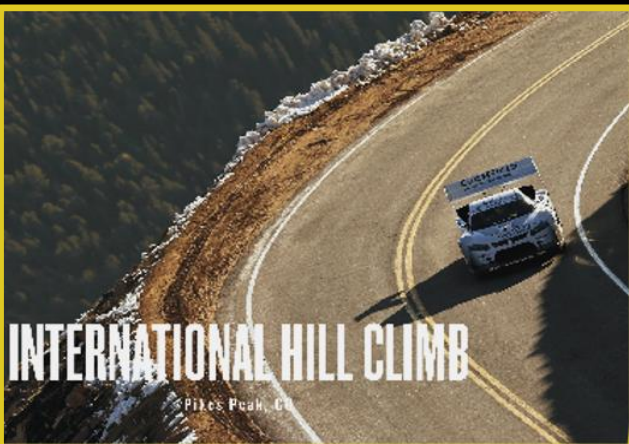
INTRODUCING THE ALL-NEW OPTIMA[®] YELLOWTOP[®] WITH PUREFLOW TECHNOLOGY[™]



ONE BATTERY



IN A SERIES OF
ULTIMATE TORTURE TESTS



STAY CONNECTED



@JCI_BatteryBeat
@johnsoncontrols

